JOURNAL OF GERIATRIC ONCOLOGY XX (2016) XXX–XXX

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Renal assessment using CKD-EPI equation is useful as an early predictor of contrast- induced nephropathy in elderly patients with cancer

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ARTICLE INFO

Article history:
Received 25 June 2015
Received in revised form 5 April 2016
Accepted 18 July 2016

Keywords:
Contrast-induced nephropathy
Renal insufficiency
Estimated glomerular filtration rate
Chronic Kidney Disease Epidemiology Collaboration equation
Modification of Diet in Renal Disease Study equation
Cockcroft-Gault formula
Elderly patient with cancer

ABSTRACT

Objectives: To assess respective roles of serum creatinine (SCr) alone and estimated glomerular filtration rate (eGFR) as an early predictor for contrast-induced nephropathy (CIN) in elderly patients with cancer.

Materials and Methods: eGFR of 348 patients at 65 years or older with malignancy who underwent contrast-enhanced computed tomography (CECT) were calculated. eGFR was calculated based on the following three equations: Chronic Kidney Disease Epidemiology Collaboration equation (CKD-EPI); Modification of Diet in Renal Disease Study (MDRD); Cockcroft-Gault (CG). CIN was subdivided into two groups: $CIN_{25\%}$ (SCr increase >25% but ≤0.5 mg/dl), and $CIN_{0.5}$ (SCr increase >0.5 mg/dl). The occurrence and clinical outcomes of CIN were determined according to SCr and eGFR.

Results: After CECT, CIN occurred in 50 (14.4%) patients, including 33 $CIN_{25\%}$ patients and 17 $CIN_{0.5}$ patients. $CIN_{0.5}$ was significantly correlated with prolonged hospitalizations and increased in-hospital mortality, but not $CIN_{25\%}$. Despite SCr < 1.5 mg/dl, preexisting renal insufficiency (RI) was observed in 47 (13.5%) patients based on CKD-EPI equation, 50 (14.4%) patients based on MDRD equation, and 144 (41.4%) patients based on CG formula. In preexisting RI, the prevalence of $CIN_{0.5}$ had an odds ratio of 15.02 (5.24 to 43.07) based on CKD-EPI equation, 13.73 (4.81 to 39.20) based on MDRD equation, and 5.03 (1.60 to 15.75) based on CG formula.

Conclusion: In elderly patients with cancer who visit the emergency department, renal assessment before CECT using CKD-EPI equation was superior to SCr alone, MDRD equation, or CG formula in predicting the occurrence of CIN related CECT.

1. Introduction

An aging society is driving the increase in the number of elderly patients with cancer who visit the emergency department (ED). For these patients, contrast-enhanced computed tomography (CECT) is a commonly used diagnostic modality in the ED. However, CECT exposes patients to radiation. In addition, it can cause complications related to contrast, including contrast-induced nephropathy (CIN) known to be significantly correlated with prolonged hospitalizations,

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http://dx.doi.org/10.1016/j.jgo.2016.07.012
1879-4068/

increased in-hospital mortality, and high medical costs.[1,2] Because elderly patients and patients with cancer are very susceptible to renal deterioration, ED physicians should be careful of using contrast in elderly patients with cancer. Preexisting renal impairment is the most important risk factor of CIN.[1–3] Preexisting renal impairment is not rare in elderly patients or patients with cancer.[4] Thus, ED physicians should carefully and accurately assess their renal function before performing CECT.

Serum creatinine (SCr), the simplest indicator of renal function, is frequently used to assess renal function of ED patients. Because SCr is a breakdown product of creatine phosphate found in muscle, the value of SCr can be directly affected by muscle mass. The normal range of SCr may differ according to factors that can affect muscle mass; age, sex, race, body size and metabolism.[5,6] Thus, SCr alone does not provide reliable indication of renal function. Elderly patients with cancer particularly have lower muscle mass than normal adults, renal assessment using absolute value of SCr alone can overestimate their renal condition. One study has reported that only ~20% of elderly patients with cancer and preexisting RI have SCr in the normal range.[7]

eGFR is a renal assessment method to predict GFR using SCr and variables to reflect muscle mass such like age, sex, race, and body size. Several equations can be used to calculate eGFR. Among these equations, Modification of Diet in Renal Disease Study (MDRD) equation and Cockcroft-Gault (CG) formula has been recommended as an initial renal assessment tool by National Kidney Foundation (NKF) and CIN Consensus Working Panel.[5,8–10] Although the calculation of eGFR using MDRD equation or CG formula is widely used for renal assessment before CECT in many hospitals, more accurate renal assessment can decrease the risk of CIN. Recently, a new Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation has been introduced.[11] However, the role of CKD–EPI equation as a predictor of CIN has not yet been verified.

The purpose of this study was to evaluate the roles of SCr alone and eGFR calculated using CKD-EPI, MDRD, and CG equation as early predictor of CIN related CECT occurred in elderly patients with cancer.

2. Materials and Methods

2.1. Study Design and Population

From September 2012 to October 2013, we retrospectively collected data from 372 patients aged 65 years or older with malignancy who underwent CECT in the ED. 24 patients who had SCr > 1.5 mg/dl before CECT, preexisting renal disease, trauma, or on chemotherapy were excluded from this study. Accordingly, the study cohort consisted of 348 patients. This study was approved by our Institutional Review Board.

2.2. Measurement of SCr

Baseline SCr was defined as the value measured just before CECT. SCr after CECT was the highest SCr value measured during three days following CECT. SCr was measured with isotope dilution mass spectrometry (IDMS) traceable analyzers (DxC 880i, Beckman Coulter, Inc.).

2.3. Definition of CIN Related CECT

CIN was defined as an increase in SCr of >25% or >0.5 mg/dl from baseline SCr from day 1 to 3 days after CECT.[12] For stratification, we subdivided the CIN group into the following two groups: $CIN_{25\%}$ (SCr increase >25% but ≤0.5 mg/dl), and $CIN_{0.5}$ (SCr increase >0.5 mg/dl).[13]

2.4. Calculation of eGFR Using EMR

Calculation of eGFR was performed using the following three equations: CKD-EPI, MDRD, and CG. Considering creatinine measurement using IDMS traceable calibration, MDRD equation was used as follow[14]:

$$\mathrm{eGFR(ml/min/1.73m^2)} = 175 \times \mathrm{SCr}^{-1.154} \times \mathrm{age}^{-0.203} (\times 0.742 \text{ if Female}) \times (\times 1.212 \text{ if Black})$$

(SCr = serum creatinine)

The values of eGFR calculated by CKD-EPI, MDRD, and CG equation were expressed as $eGFR_{CKD\text{-}EPI}$, $eGFR_{MDRD}$, and $CrCl_{CG}$, respectively. eGFR less than 60 ml/min/1.73 m^2 was defined as preexisting RI.[8] Preexisting RI calculated based on CKD-EPI, MDRD, and CG equation were expressed as Preexisting $RI_{CKD\text{-}EPI}$, Preexisting RI_{MDRD}, and Preexisting RI_{CG}, respectively.

We used the electronic medical records (EMR) for eGFR calculation. The processes of eGFR calculation were conducted as follows: selecting eGFR equation, producing calculation program according to the equation, connecting between calculation program and variables in EMR database for automatic input of variables for eGFR calculation, and producing shortcut for eGFR calculation. For convenience, these processes were posted at the laboratory window. Value of eGFR was expressed as two decimal places with date. Results were classified according to NKF guidelines.

2.5. Clinical Outcomes of CIN Related to CECT

Clinical outcomes of CIN were assessed by the degree of nephropathy developed after CECT, in-hospital mortality, and length of stay (LOS). The degree of nephropathy developed after CECT was assessed by the value of eGFR calculated with CKD-EPI, MDRD, or CG equation. Newly developed eGFR <60 ml/min/1.73 m^2 after CECT was defined as RI after CECT. RI after CECT calculated by CKD-EPI, MDRD, and CG equation were expressed as $RI_{CKD\text{-}EPI}$ after CECT, RI_{MDRD} after CECT, and RI_{CG} after CECT, respectively. In-hospital mortality was defined as all-cause hospital death occurred after CECT. LOS was defined as the time elapsed between the day of CECT and the day of discharge or death.

2.6. Primary Data Analysis

Shapiro–Wilk test was performed to determine whether data had normal distribution. Continuous variables were expressed

Please cite this article as: Park S-Y, Lee K-W, Renal assessment using CKD-EPI equation is useful as an early predictor of contrast-induced nephropathy in elderly patients with ..., *J Geriatr Oncol* (2016), http://dx.doi.org/10.1016/j.jgo.2016.07.012